



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/760,884	01/17/2001	Panayotis C. Andricacos	YOR20000578US1	4972

7590 11/22/2002

Connolly Bove Lodge & Hutz LLP
Suite 800
1990 M Street, N.W.
Washington, DC 20036-3425

[REDACTED] EXAMINER

SMITH HICKS, ERICA D

ART UNIT	PAPER NUMBER
1741	22

DATE MAILED: 11/22/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/760,884	ANDRICACOS ET AL.
	Examiner	Art Unit
	Erica Smith-Hicks	1741

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 17 January 2001.
- 2a) This action is FINAL. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 10-23 is/are rejected.
- 7) Claim(s) _____ is/are objected to.
- 8) Claim(s) 1-9 and 24-28 are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) The proposed drawing correction filed on _____ is: a) approved b) disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) All b) Some * c) None of:
 1. Certified copies of the priority documents have been received.
 2. Certified copies of the priority documents have been received in Application No. _____.
 3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

- 14) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) The translation of the foreign language provisional application has been received.
- 15) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input checked="" type="checkbox"/> Interview Summary (PTO-413) Paper No(s). 2 . |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ . | 6) <input type="checkbox"/> Other: |

Art Unit: 1741

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-9, and 28 drawn to a printed circuit board, classified in class 174, subclass 256.
 - II. Claims 10-23 drawn to a method of making a printed circuit board, classified in class 205, subclass 125.
 - III. Claims 24-27, drawn to an apparatus for making a printed circuit board, classified in class 204, subclass 194+.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions II and III are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the apparatus as claimed can be used to practice another and materially different process, such as the method of making an electronic structure that does not have a barrier layer.

3. Inventions II and I are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process

Art Unit: 1741

(MPEP § 806.05(f)). In the instant case the product as claimed can be made by another materially different process, such as by electroless deposition, CVD, PVD or various other semiconductor manufacturing techniques for depositing the copper interconnect layer.

4. Inventions III and I are related as apparatus and product made. The inventions in this relationship are distinct if either or both of the following can be shown: (1) that the apparatus as claimed is not an obvious apparatus for making the product and the apparatus can be used for making a different product or (2) that the product as claimed can be made by another and materially different apparatus (MPEP § 806.05(g)). In this case the apparatus as claimed is not an obvious apparatus for making the product and the apparatus can be used for making a different product, such as an electronic structure that does not have a barrier layer.

5. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

6. During a telephone conversation between Examiner Jose Alcala and Atty. Burt Amerneck on February 28, 2002 a provisional election was made with traverse to prosecute the invention of Group II, claims 10-23. Affirmation of this election must be made by applicant in replying to this Office action. Claims 1-9 and 24-28 are withdrawn

Art Unit: 1741

from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

**** Note *** Claim 28 was previously grouped with Group II claims 10-23 in error. As a product-by-process claim, claim 28 is classified with the product claims of Group I.*

7. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Information Disclosure Statement

8. Applicants are encouraged to file an Information Disclosure Statement pursuant to 37 CFR 1.98(b) which requires a list of all patents, publications, or other information submitted for proper consideration by the Office.

Claim Objections

9. Claim 10 is objected to because of the following informalities: --line 6 of the claim—delete “both” and substitute therein “bath”.

Claim 19 is objected to because of the following informalities: --line 2 of the claim—amend “or a salt [of] thereof[.]”

Appropriate correction is required.

Claim Rejections - 35 USC § 102

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

11. Claims 10 and 13-20 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by GILTON et al. US 5,151,168.

GILTON et al., (hereafter GILTON) teach a method for fabricating an electronic structure which comprises forming an insulating material on a substrate (dielectric layer 11, as shown in Figure 1 and described in the reference at col. 4, line 48); lithographically forming recesses for lines and or vias having sidewalls and bottom surface in the insulating material in which interconnection conductor material will be deposited (shown in Figure 1; also see col. 4, lines 49-50); depositing a barrier layer on sidewalls and bottom surface of the recess (reference numeral 12, as shown in Figure 1

Art Unit: 1741

and described in the reference at col. 4, lines 60-65); depositing copper on the barrier layer by plating from a bath having a pH of 12.89 or greater, a source of cupric ions and a complexing agent (col. 5, lines 12-20); at a current density of less than 10 $\mu\text{A}/\text{cm}^2$ which is in the range of Applicants' intent to claim 5-25 $\mu\text{A}/\text{cm}^2$.

Claims 13 and 15 are rejected because GILTON teach the method wherein the barrier layer is selected from the group consisting of tungsten, alloys of tungsten, titanium and its alloys, titanium nitride, tantalum, tantalum nitride and tantalum silicon nitride at col. 7, lines 9-12.

Claim 14 is rejected because GILTON teach the method wherein the barrier layer has a thickness of at least about 4 nanometers, specifically a thickness of 20-30 nanometers at col. 4, line 65.

Claim 16 is rejected because GILTON teach the method wherein the dielectric layer is silicon dioxide at col. 5, lines 4-5.

Claim 17 is rejected because GILTON teach the method wherein the recess has an aspect ration of greater than 3:1 at col. 8, lines 5-6.

Regarding claim 18, GILTON et al. teach a plating bath temperature at ambient 25° C (col. 5, lines 12-14 of the reference) which is within the range of Applicants' limitation of about 22° C. Moreover, GILTON teach the method wherein the bath temperature is maintained within the range of 20° C-35° C at col. 7, lines 7-9.

Claim 19 is rejected because GILTON teach the method wherein the source of cupric ions is CuSO₄ and the complexing agent is EDTA or salt a salt thereof at col. 5, lines 12-16 of the reference.

Art Unit: 1741

Claim 20 is rejected because GILTON teach the method wherein the electroplating bath comprises sodium hydroxide or potassium hydroxide at col. 5, lines 28-29.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

13. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

14. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

15. Claims 11 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over GILTON et al..

GILTON et al., is as applied, argued and disclosed above and incorporated herein.

While GILTON et al. teach the deposition of a copper layer to the desired uniform thickness, they remain silent as to the specific thickness.

However, in method claims, it is the overall method steps that are given patentable weight not the structural limitations thereof unless the structural limitations materially alter the overall method *In re Leesona Corp.*, 185 USPQ 156; *Ex parte Pfeiffer*, 1962 CD 408; *Ex parte Kangas*, 125 USPQ 419; *Ex parte Foreman*, 1924 CD 47; *Ex parte Nelson et al.*, 82 USPQ 115; *In re Winder*, 1957 CD 175; *Ex parte Hart*, 117 USPQ 193. It does not appear the overall method of GILTON et al. is significantly altered as a function of the thickness of the electrodeposited copper layer. The GILTON et al. methods as well as the instant method are both processes for forming high aspect ratio damascene structures. As such, the thickness of the thus formed structure appear to be a matter of designer choice and optimization given the art known and technology definitions of the size parameters of "high-aspect" microstructures. The electrolytic deposition of copper filling the recess is allowed to occur until sufficient thickness. Therefore, the limitations of claims 11 and 12 are deemed obvious in view of the prior art teachings.

Claims 11 and 12 are rejected because it would have been obvious to a person of skill in the art at the time of the invention to have deposited copper filler into the recesses of a substrate by an electrolytic deposition as disclosed by GILTON because GILTON have shown that the electroplating technique would have provided for seamless filling of the recess with the added ability to control the deposition of material to a sufficient thickness.

16. Claims 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over GILTON as applied to claims 1 and 13-20 above, and further in view of TING et al., US 5,897,692.

GILTON et al., are as applied, argued and disclosed above and incorporated herein.

GILTON et al. remain silent as to all possible bath constituents for the copper electroplating bath.

TING teach a method of electrolytically depositing copper filler in the trenches of a printed circuit board wherein the method teaches the use of plating additives specifically a stabilizer and surfactant at col. 10, lines 43-55 of the reference as shown below:

(29) The solutions employed in the present invention for electroless deposition of Cu or electroplating of Cu or a Cu alloy are conventional and, hence, not described herein in detail. It has been found particularly suitable to employ an electroless solution comprising copper sulfate to supply Cu.²⁺ cations, ethylenediaminetetraacetic acid (EDTA) as a complexing agent for Cu.²⁺ cations, quaternary ammonium hydroxides or potassium hydroxide (KOH)

to supply the OH⁻ ions, formaldehyde (HCHO) or glyoxylic acid as a reducing agent, RHODAFAC RE 610 or a polyethylene glycol as a surfactant and wetting agent, and ammonium cyanide or 2,2"-dipyridyl as a stabilizer and ductility promoter.

GILTON and TING in combination teach all of the limitations of Applicants' claims 21-23 and the references are combinable as they are from the same technology area of electroplating copper interconnect structures.

It would have been obvious to a skilled artisan at the time the invention was made to have employed the teachings of TING for bath additives in the plating method of GILTON because TING have shown that the use of a stabilizer and surfactant in the copper plating bath would have promoted ductility and prevented the formation of nodules in the electroplated copper deposit thus significantly advancing void -less fill of the via structure.

Double Patenting

17. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

18. Claims 10-23 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-5, 7, 8, 12 and 14-18 of U.S. Patent No. 6,416,812 to ANDRICACOS et al. in view of GILTON et al. US 5,151,168.

ANDRICACOS et al., teach a method for fabricating an electronic structure which comprises depositing copper on the barrier layer by plating from a bath having a pH of 12.89 or greater, a source of cupric ions and a complexing agent (col. 6, lines 60-67). Each of these limitations of instant claim 10 are taught in the reference at **claim 1**.

The only differences between the instant independent claim and that to ANDRICACOS et al. '812 is that the prior art employs an electroless plating technique while Applicants' claim an electroplating technique. However, in the background of the prior art reference, at col. 2, lines 5-8, ANDRICACOS et al., teach electroplating for depositing the copper layer. Further claim 1 of ANDRICACOS '812 fails to expressly recite the lithographically forming of recesses for lines and or vias having sidewalls and bottom surface in the insulating material in which interconnection conductor material will be deposited nor the deposition of the barrier layer on sidewalls and bottom surface of the recess.

While ANDRICACOS et al., suggest electroplating may be used; the reference fails to teach the application of current /current density nor the aforementioned recess and barrier limitations.

These teachings are provided by GILTON et al., who disclose a process for metallizing integrated circuits with electrolytically deposited copper, wherein the copper is deposited from a bath comprising a source of cupric ions, complexing agent, a pH of

Art Unit: 1741

12.89 or greater (specifically 13.5) at a current density of less than 1.0 millamps, which falls within the range of Applicants' .05-2.5 millamps (see Abstract, lines 1-5, 15-19; and **claims 1-12**). The copper is plated into openings of the substrate with a barrier layer formed thereover (see **claim 1**, lines 1-7).

ANDRICACOS et al. and GILTON et al., in combination, teach all of the limitations of Applicants' independent claim 10 and are combinable as they are from the same technology of forming high aspect ratio interconnect structures employing copper plating baths.

It would have been obvious to a person of skill in the art at the time of the invention to have employed the current density of GILTON in an electroplating technique to form the electronic structure of ANDRICACOS because GILTON have shown that electroplating would have allowed for selective deposition and seamless fill of the trenched structure.

Claim 11 is rejected because the primary reference to ANDRICACOS discloses the method wherein the copper is deposited to a thickness of 10-100 nanometers in **claim 2 of the reference**.

Claim 12 is rejected because ANDRICACOS teach the method wherein the copper is deposited to a thickness of 20-50 nanometers in **claim 3 of the reference**.

Claim 13 is rejected because ANDRICACOS teach the method wherein the barrier layer is selected from the group consisting of tungsten, alloys of tungsten, titanium and its alloys, titanium nitride, tantalum, tantalum nitride and tantalum silicon nitride in **claim 5 of the reference**.

Claim 14 is rejected because ANDRICACOS teach the method wherein the barrier layer has a thickness of at least about 4 nanometers in **claim 6 of the reference**.

Claim 15 is rejected because ANDRICACOS teach the method wherein the barrier layer is tungsten in **claim 7 of the reference**.

Claim 16 is rejected because ANDRICACOS teach the method wherein the dielectric layer is silicon dioxide in **claim 8 of the reference**.

Claim 17 is rejected because ANDRICACOS teach the method wherein the recess has an aspect ratio of greater than 3:1 in **claim 12 of the reference**.

Regarding claim 18, GILTON et al. teach a plating bath temperature at ambient 25° C or between 20°C-35° C in **claims 4 and 5 of the reference** which is within the range of Applicants' limitation of about 22° C. While GILTON et al. may not expressly teach Applicants' exact temperature, the selection of reaction parameters, such as temperature, concentration and pressure would have been obvious (*In re Aller* 105 USPQ 233, 255 (CCPA 1955)). Therefore, claim 18 is rejected because it would have been obvious to have employed a temperature at or very near ambient as taught by GILTON et al. in ANDRICACOS because GILTON et al., have shown that the constant temperature of the bath near room temperature would have maintained the requisite stable bath which would have facilitated plating uniformity through control of the bath.

Claim 19 is rejected because ANDRICACOS teach the method wherein the source of cupric ions is CuSO₄ and the complexing agent is EDTA or salt a salt thereof in **claim 14 of the reference**.

Claim 20 is rejected because ANDRICACOS teach the method wherein the electroplating bath comprises sodium hydroxide or potassium hydroxide at col. 8, lines **in claim 15 of the reference.**

Claim 21 is rejected because ANDRICACOS teach the method wherein the bath comprises a stabilizer and surfactant **in claim 16 of the reference.**

Claim 22 is rejected because ANDRICACOS teach the method wherein the stabilizer is a pyridyl derivative, specifically 2,2'-dipyridyl **in claim 17 of the reference.**

Claim 23 is rejected because the method of ANDRICACOS comprises the inclusion of cyanide ions in the plating bath **in claim 18 of the reference.**

Conclusion

19. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. BROWN et al., US 6,168,7047 B1 and CHEN et al. US 6,139,905 who disclose a method for forming interconnect structures comprising the use of tantalum, titanium, tungsten and alloys thereof barrier layers; CHEN et al. US 6,139,905; and KOTSUKA et al., US 5,897,692 who teach the use of stabilizers and surfactants in copper plating baths.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erica Smith-Hicks whose telephone number is 703/ 305-7645. The examiner can normally be reached on Wed.-Fri., from 8:00 a.m.-6:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 703/ 308-3322. The fax phone numbers for the organization where this application or proceeding is assigned are 703/ 872-9310 for regular communications and 703/ 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703/ 308-0661.

R. M. Myers

NAM NGUYEN Erica Smith-Hicks
SUPERVISORY PATENT EXAMINER Examiner
TECHNOLOGY CENTER 1700 Art Unit 1741

ESH
November 15, 2002